Instruction Manual MS series

Scientific calculator

Please read carefully before use and safe keeping, for inspection

Before getting started...

■ Modes

Before starting a calculation, you must first enter the correct mode as indicated in the table below.

To perform this type of calculation:	Perform this key operation:	To enter this mode:
Basic arithmetic calculations	MODE 1	COMP
Standard deviation	MODE 2	SD
Regression calculations	MODE 3	REG

- Pressing the MODE key more than once displays additional setup screens. Setup screens are described in the sections of this manual where they are actually used to change the calculator setup.
- In this manual, the name of the mode you need to enter in order to perform the calculations being described is indicated in the main title of each section.

Example: Statistical Calculations (SD / REG)

Note!

- To return the calculation mode and setup to the initial defaults shown below, press SHIFT CLR 2 (Mode) =.

Calculation Mode:	COMP
Angle Unit:	Deg
Exponential Display Format:	Norm 1
Fraction Display Format:	a b/c
Decimal Point Character:	Dot

- Mode indicators appear in the upper part of the display.
- Be sure to check the current calculation mode (SD, REG, COMP) and angle unit setting (Deg, Rad, Gra) before beginning a calculation.

■ Multi-statements

A multi-statement is an expression that is made up of two or more smaller expressions, which are joined using a colon (:).

- **Example:** To add 2+3 and then multiply the result by 4

2 + 3 ALPHA : Ans × 4 =

2+3 → 5

Ans×4 → 20.

■ Exponential Display Formats

This calculator can display up to 10 digits. Larger values are automatically displayed using exponential notation. In the case of decimal values, you can select between two formats that determine at what point exponential notation is used.

- To change the exponential display format, press the MODE key a number of times until you reach the exponential display format setup screen shown below.

```
Fix Sci Norm
1   2   3
```

- Press 3. On the format selection screen that appears, press 1 to select Norm 1 or 2 for Norm 2.

• Norm 1

With Norm 1, exponential notation is automatically used for integer values with more than 10 digits and decimal values with more than two decimal places.

• Norm 2

With Norm 2, exponential notation is automatically used for integer values with more than 10 digits and decimal values with more than nine decimal places.

- All of the examples in this manual show calculation results using the Norm 1 format.

■ Decimal Point and Separator Symbols

You can use the display setup (Disp) screen to specify the symbols you want for the decimal point and 3-digit separator.

- To change the decimal point and separator symbol setting, press the MODE key a number of times until you reach the setup screen shown below.

```
Disp
1
```

- Display the selection screen.
  1 ▶
- Press the number key (1 or 2) that corresponds to the setting you want to use.
  1 (Dot): Period decimal point, comma separator
  2 (Comma): Comma decimal point, period separator

■ Initializing the Calculator

- Perform the following key operation when you want to initialize the calculation mode and setup, and clear replay memory and variables.
  SHIFT CLR 3 (All) =

Basic Calculations COMP

■ Arithmetic Calculations

Use the MODE key to enter the COMP Mode when you want to perform basic calculations.
COMP ..... MODE 1

- Negative values inside of calculations must be enclosed within parentheses. For details, see "Order of Operations."
- It is not necessary to enclose a negative exponent within parentheses.

sin 2.34 × 10^{-5} → sin 2.34 EXP (−) 5

- **Example 1:** 3×(5×10^{-9}) = ***1.5×10⁻⁸***

3 × 5 EXP (−) 9 =

- **Example 2:** 5×(9+7) = ***80***

5 × (9 + 7) =

- You can skip all) operations before =.

■ Fraction Operations

• Fraction Calculations

- Values are displayed in decimal format automatically whenever the total number of digits of a fractional value (integer+numerator+denominator+separator marks) exceeds 10.

- **Example 1:** $\frac{2}{3} + \frac{1}{5} = \frac{13}{15}$

2 a b/c 3 + 1 a b/c 5 = → 13⌟15.

- **Example 2:** $3\frac{1}{4} + 1\frac{2}{3} = 4\frac{11}{12}$

3 a b/c 1 a b/c 4 +
1 a b/c 2 a b/c 3 = → 4⌟11⌟12.

- **Example 3:** $\frac{2}{4} = \frac{1}{2}$

2 a b/c 4 = → 1⌟2.

- **Example 4:** $\frac{1}{2} + 1.6 = 2.1$

1 a b/c 2 + 1.6 = → 2.1

- Results of calculations that mix fraction and decimal values are always decimal.

• Decimal ↔ Fraction Conversion

- Use the operation shown below to convert calculation results between decimal values and fraction values.
- Note that conversion can take as long as two seconds to perform.

- **Example 1:** 2.75 = $2\frac{3}{4}$ (Decimal → Fraction)

2.75 = → 2.75
a b/c → 2⌟3⌟4.
= $\frac{11}{4}$ SHIFT d/c → 11⌟4.

- **Example 2:** $\frac{1}{2}$ ↔ 0.5 (Fraction ↔ Decimal)

1 a b/c 2 = → 1⌟2.
a b/c → 0.5
a b/c → 1⌟2.

• Mixed Fraction ↔ Improper Fraction Conversion

- **Example:** $1\frac{2}{3} \leftrightarrow \frac{5}{3}$

1 a b/c 2 a b/c 3 = → 1⌟2⌟3.
SHIFT d/c → 5⌟3.
SHIFT d/c → 1⌟2⌟3.

- You can use the display setup (Disp) screen to specify the display format when a fraction calculation result is greater than one.
- To change the fraction display format, press the MODE key a number of times until you reach the setup screen shown below.

```
Disp
1
```

- Display the selection screen.
  1
- Press the number key (1 or 2) that corresponds to the setting you want to use.
  1 (a b/c): Mixed fraction
  2 (d/c): Improper fraction
- An error occurs if you try to input a mixed fraction while the d/c display format is selected.

■ Degrees, Minutes, Seconds Calculations

- You can perform sexagesimal calculations using degrees (hours), minutes, and seconds, and convert between sexagesimal and decimal values.
- **Example 1:** To convert the decimal value 2.258 to a sexagesimal value and then back to a decimal value

2.258 = → 2.258
SHIFT ... → 2°15°28.8
... → 2.258

- **Example 2:** To perform the following calculation:
  12°34'56" × 3.45

12 ... 34 ... 56 ... × 3.45 = → 43°24°31.2

■ FIX, SCI, RND

- To change the settings for the number of decimal places, the unmber of significant digits, or the exponential display format, press the MODE key a number of times until you reach the setup screen shown below.

```
Fix Sci Norm
1   2   3
```

- Press the number key (1, 2, or 3) that corresponds to the setup item you want to change.
  1 (Fix): Number of decimal places
  2 (Sci): Number of significant digits
  3 (Norm): Exponential display format

- **Example 1:** 200 ÷ 7 × 14 =

200 ÷ 7 × 14 = → 400.

(Specifies three decimal places.) MODE ..... 1 (Fix) 3 → FIX 400.000

(Internal calculation continues using 12 digits.) 200 ÷ 7 = → 28.571
× 14 = → 400.000

The following performs the same calculation using the specified number of decimal places.

200 ÷ 7 = → 28.571

(Internal rounding) SHIFT Rnd → 28.571

× 14 = → 399.994

- Press MODE ..... 3 (Norm) 1 to clear the Fix specification.
- **Example 2:** 1 ÷ 3, displaying result with two significant digits (Sci 2)

MODE ..... 2 (Sci) 2 1 ÷ 3 = → SCI 3.3-01

- Press MODE ..... 3 (Norm) 1 to clear the Sci specification.

Memory Calculations COMP

Use the MODE key to enter the COMP Mode when you want to perform a calculation using memory.
COMP ..... MODE 1

■ Independent Memory

- Values can be input directly into memory, added to memory, or subtracted from memory. Independent memory is convenient for calculating cumulative totals.
- Independent memory uses the same memory area as variable M.
- To clear independent memory (M), input 0 SHIFT STO M (M+).

- **Example:**

23 + 9 = ***32*** → 23 + 9 SHIFT STO M (M+)
53 − 6 = ***47*** → 53 − 6 M+
−) 45 × 2 = ***90*** → 45 × 2 SHIFT M−
(Total) ***−11*** → RCL M (M+)

■ Variables

- There are nine variables (A through F, M, X and Y), which can be used to store data, constants, results, and other values.
- Use the following operation to delete deat assigned to a particular variable: 0 SHIFT STO A . This operation deletes the data assigned to variable A.
- Perform the following key operation when you want to clear the values assigned to all of the variables.
  SHIFT CLR 1 (Mcl) =

- **Example:** 193.2 ÷ 23 = ***8.4***
  193.2 ÷ 28 = ***6.9***

193.2 SHIFT STO A ÷ 23 =
ALPHA A ÷ 28 =

Scientific Function Calculations COMP

Use the MODE key to enter the COMP Mode when you want to perform scientific function calculations.
COMP ..... MODE 1

- Certain types of calculations may take a long time to complete.
- Wait for the result to appear on the display before searting the next calculation.
- π = 3.14159265359

■ Trigonometric/Inverse Trigonometric Functions

- To change the default angle unit (degrees, radians, grads), press the MODE key a number of times until you reach the angle unit setup screen shown below.

```
Deg Rad Gra
1   2   3
```

- Press the number key (1, 2, or 3) that corresponds to the angle unit you want to use.

(90° = $\frac{\pi}{2}$ radians = 100 grads)

- **Example 1:** sin 63°52'41" = ***0.897859012***

MODE ..... 1 (Deg)
sin 63 ... 52 ... 41 ... =

- **Example 2:** $\cos\left(\frac{\pi}{3}\text{ rad}\right) = 0.5$

  MODE ····· 2 (Rad)

  cos (SHIFT π ÷ 3) =

- **Example 3:** $\cos^{-1}\frac{\sqrt{2}}{2} = 0.25\,\pi\,(\text{rad})\left(=\frac{\pi}{4}\text{ (rad)}\right)$

  MODE ····· 2 (Rad)

  SHIFT cos⁻¹ (√ 2 ÷ 2) = Ans × SHIFT π =

- **Example 4:** $\tan^{-1} 0.741 = 36.53844577°$

  MODE ····· 1 (Deg)

  SHIFT tan 0.741 =

Hyperbolic/Inverse Hyperbolic Functions

- **Example 1:** $\sinh 3.6 = 18.28545536$ hyp sin 3.6 =
- **Example 2:** $\sinh^{-1} 30 = 4.094622224$

  hyp SHIFT sin 30 =

Common and Natural Logarithms/ Antilogarithms

- **Example 1:** $\log 1.23 = 0.089905111$ log 1.23 =
- **Example 2:** $\ln 90\ (=\log_e 90) = 4.49980967$

  ln 90 =

  $\ln e = 1$ ln ALPHA e =
- **Example 3:** $e^{10} = 22026.46579$ SHIFT e^x 10 =
- **Example 4:** $10^{1.5} = 31.6227766$ SHIFT 10^x 1.5 =
- **Example 5:** $2^{-3} = 0.125$ 2 ^ (−) 3 =
- **Example 6:** $(-2)^4 = 16$ ((−) 2) ^ 4 =
- Negative values inside of calculations must be enclosed within parentheses. For details, see "Order of Operations."

Square Roots, Cube Roots, Roots, Squares, Cubes, Reciprocals, Factorials, Random Numbers, π, and Permutation/Combination

- **Example 1:** $\sqrt{2}+\sqrt{3}\times\sqrt{5} = 5.287196909$

  √ 2 + √ 3 × √ 5 =
- **Example 2:** $\sqrt[3]{5}+\sqrt[3]{-27} = -1.290024053$

  SHIFT ∛ 5 + SHIFT ∛ ((−) 27)
- **Example 3:** $\sqrt[7]{123}\ (=123^{\frac{1}{7}}) = 1.988647795$

  7 SHIFT ∛ 123 =
- **Example 4:** $123 + 30^2 = 1023$ 123 + 30 x² =
- **Example 5:** $12^3 = 1728$ 12 x³ =
- **Example 6:** $\frac{1}{\frac{1}{3}-\frac{1}{4}} = 12$

  (3 x⁻¹ − 4 x⁻¹) x⁻¹ =
- **Example 7:** $8! = 40320$ 8 SHIFT x! =
- **Example 8:** To generate a random number between 0.000 and 0.999

  SHIFT Ran# = → 0.664

  (The above value is a sample only. Results differ each time.)
- **Example 9:** $3\pi = 9.424777961$ 3 SHIFT π =
- **Example 10:** To determine how many different 4-digit values can be produced using the numbers 1 through 7
  - Numbers cannot be duplicated within the same 4-digit value (1234 is allowed, but 1123 is not). **(840)**

  7 SHIFT nPr 4 =
- **Example 11:** To determine how many different 4-member groups can be organized in a group of 10 individuals **(210)**

  10 nCr 4 =

Angle Unit Conversion

- Press SHIFT DRG▶ to display the following menu.

  D R G
  1 2 3
- Pressing 1, 2, or 3 converts the displayed value to the corresponding angle unit.
- **Example:** To convert 4.25 radians to degrees

  MODE ····· 1 (Deg)

  4.25 SHIFT DRG▶ 2 (R) = → 4.25r 243.5070629

Coordinate Conversion (Pol (x, y), Rec (r, θ))

- Calculation results are automatically assigned to variables E and F.
- **Example 1:** To convert polat coordinates ($r=2$, $\theta=60°$) to rectangular coordinates (x, y) (Deg)

  $x = 1$ SHIFT Rec(2 , 60) =

  $y = 1.732050808$ RCL F
- Press RCL E to display the value of x, or RCL F to display the value of y.
- **Example 2:** To convert rectangular coordinates (1, $\sqrt{3}$) to polar coordinates (r, θ) (Rad)

  $r = 2$ Pol(1 , √ 3) =

  $\theta = 1.047197551$ RCL F
- Press RCL E to display the value of r, or RCL F to display the value of θ.

Engineering Notation Calculations

- **Example 1:** To convert 56,088 meters to kilometers

  → 56.088×10^3 (km) 56088 = ENG
- **Example 2:** To convert 0.08125 grams to milligrams

  → 81.25×10^{-3} (mg) 0.08125 = ENG

Statistical Calculations SD REG

Standard Deviation SD

Use the MODE key to enter the SD Mode when you want to perform statistical calculations using standard deviation.

SD ..... MODE 2

- In the SD Mode and REG Mode, the M+ key operates as the DT key.
- Always start data input with SHIFT CLR 1 (Scl) = to clear statistical memory.
- Input data using the key sequence shown below.

  <x-data> DT
- Input data is used to calculate values for n, Σx, Σx^2, $\bar{x}$, σ_n and σ_{n-1}, which you can recall using the key operations noted nearby.

To recall this type of value:	Perform this key operation:
Σx^2	SHIFT S-SUM 1
Σx	SHIFT S-SUM 2
n	SHIFT S-SUM 3
$\bar{x}$	SHIFT S-VAR 1
σ_n	SHIFT S-VAR 2
σ_{n-1}	SHIFT S-VAR 3

- **Example:** To calculate σ_{n-1}, σ_n, $\bar{x}$, n, Σx, and Σx^2 for the following data : 55, 54, 51, 55, 53, 53, 54, 52

  In the SD Mode:

  SHIFT CLR 1 (Scl) = (Stat clear)

  55 DT → n= SD 1.

  Each time you press DT to register your input, the number of data input up to that point is indicated on the display (n value).

  54 DT 51 DT 55 DT
  53 DT 54 DT 52 DT

  Sample Standard Deviation (σ_{n-1}) = 1.407885953 — SHIFT S-VAR 3 =

  Population Standard Deviation (σ_n) = 1.316956719 — SHIFT S-VAR 2 =

  Arithmetic Mean ($\bar{x}$) = 53.375 — SHIFT S-VAR 1 =

  Number of Data (n) = 8 — SHIFT S-SUM 3 =

  Sum of Values (Σx) = 427 — SHIFT S-SUM 2 =

  Sum of Squares of Values (Σx^2) = 22805 — SHIFT S-SUM 1 =

Regression Calculations REG

Use the MODE key to enter the REG Mode when you want to perform statistical calculations using regression.

REG ..... MODE 3

In the SD Mode and REG Mode, the M+ key operates as the DT key.

Entering the REG Mode displays screens like the ones shown below.

Lin Log Exp ▪
1 2 3

▶ ↓ ↑ ◀

▪Pwr Inv Quad
1 2 3

- Press the number key (1, 2 or 3) that corresponds to the type of regression you want to use.
  - 1 (Lin): Linear regression
  - 2 (Log): Logarithmic regression
  - 3 (Exp): Exponential regression
  - ▶ 1 (Pwr): Power regression
  - ▶ 2 (Inv): Inverse regression
  - ▶ 3 (Quad): Quadratic regression
- Always start data input with SHIFT CLR 1 (Scl) = to clear statistical menary.
- Input data using the key sequence shown below.

  <x-data> , <y-data> DT
- The values produced by a regression calculation depend on the values input, and results can be recalled using the key operations shown in the table below.

To recall this type of value:	Perform this key operation:
Σx^2	SHIFT S-SUM 1
Σx	SHIFT S-SUM 2
n	SHIFT S-SUM 3
Σy^2	SHIFT S-SUM ▶ 1
Σy	SHIFT S-SUM ▶ 2
Σxy	SHIFT S-SUM ▶ 3
$\bar{x}$	SHIFT S-VAR 1
$x\sigma_n$	SHIFT S-VAR 2
$x\sigma_{n-1}$	SHIFT S-VAR 3
$\bar{y}$	SHIFT S-VAR ▶ 1
$y\sigma_n$	SHIFT S-VAR ▶ 2
$y\sigma_{n-1}$	SHIFT S-VAR ▶ 3
Regression coefficient A	SHIFT S-VAR ▶ ▶ 1
Regression coefficient B	SHIFT S-VAR ▶ ▶ 2
Regression coefficient C	SHIFT S-VAR ▶ ▶ 3
$\hat{x}_1$	SHIFT S-VAR ▶ ▶ ▶ 1
$\hat{x}_2$	SHIFT S-VAR ▶ ▶ ▶ 2
$\hat{y}$	SHIFT S-VAR ▶ ▶ ▶ 3
Correlation coefficient r	SHIFT S-VAR ▶ ▶ 3
$\hat{x}$	SHIFT S-VAR ▶ ▶ ▶ 1
$\hat{y}$	SHIFT S-VAR ▶ ▶ ▶ 2

- The following table shows the key operations you should use to recall results in the case of quadratic regression.

To recall this type of value:	Perform this key operation:
Σx^3	SHIFT S-SUM ▶ ▶ 1
$\Sigma x^2 y$	SHIFT S-SUM ▶ ▶ 2
Σx^4	SHIFT S-SUM ▶ ▶ 3
Regression coefficient C	SHIFT S-VAR ▶ ▶ 3
$\hat{x}_1$	SHIFT S-VAR ▶ ▶ ▶ 1
$\hat{x}_2$	SHIFT S-VAR ▶ ▶ ▶ 2
$\hat{y}$	SHIFT S-VAR ▶ ▶ ▶ 3

- The values in the above tables can be used inside of expressions the same way you use variables.

• Linear Regression

- The regression formula for linear regression is: $y = A + Bx$.
- **Example:** Atmospheric Pressure vs. Temperature

Temperature	Atmospheric Pressure
10°C	1003 hPa
15°C	1005 hPa
20°C	1010 hPa
25°C	1011 hPa
30°C	1014 hPa

Perform linear regression to determine the regression formula terms and correlation coefficient for the data nearby. Next, use the regression formula to estimate atmospheric pressure at −5°C and temperature at 1000 hPa. Finally, calculate the coefficient of determination (r^2) and sample covariance $\left(\frac{\Sigma xy - n\cdot\bar{x}\cdot\bar{y}}{n-1}\right)$.

In the REG Mode:

1 (Lin)

SHIFT CLR 1 (Scl) = (Stat clear)

10 , 1003 DT → n= REG 1.

Each time you press DT to register your input, the number of data input up to that point is indicated on the display (n value).

15 , 1005 DT
20 , 1010 DT 25 , 1011 DT
30 , 1014 DT

Regression Coefficient A = 997.4 — SHIFT S-VAR ▶ ▶ 1 =

Regression Coefficient B = 0.56 — SHIFT S-VAR ▶ ▶ 2 =

Correlation Coefficient r = 0.982607368 — SHIFT S-VAR ▶ ▶ 3 =

Atmospheric Pressure at −5°C = 994.6 — ((−) 5) SHIFT S-VAR ▶ ▶ ▶ 2 =

Temperature at 1000 hPa = 4.642857143 — 1000 SHIFT S-VAR ▶ ▶ ▶ 1 =

Coefficient of Determination = 0.965517241 — SHIFT S-VAR ▶ ▶ 3 x^2 =

Sample Covariance = 35 — (SHIFT S-SUM ▶ 3 − SHIFT S-SUM 3 × SHIFT S-VAR 1 × SHIFT S-VAR ▶ 1 ÷ (SHIFT S-SUM 3 − 1) =

• Logarithmic, Exponential, Power, and Inverse Regression

- Use the same key operations as linear regression to recall results for these types of regression.
- The following shows the regression formulas for each type of regression.

Logarithmic Regression	$y = A + B\cdot\ln x$
Exponential Regression	$y = A\cdot e^{B\cdot x}$ ($\ln y = \ln A + Bx$)
Power Regression	$y = A\cdot x^B$ ($\ln y = \ln A + B\ln x$)
Inverse Regression	$y = A + B\cdot{}^1/_x$

• Quadratic Regression

- The regression formula for quadratic regression is: $y = A + Bx + Cx^2$.
- **Example:**

x_i	y_i
29	1.6
50	23.5
74	38.0
103	46.4
118	48.0

Perform quadratic regression to determine the regression formula terms for the data nearby. Next, use the regression formula to estimate the values for $\hat{y}$ (estimated value of y) for $x_i = 16$ and $\hat{x}$ (estimated value of x) for $y_i = 20$.

In the REG Mode:

▶ 3 (Quad)

SHIFT CLR 1 (Scl) = (Stat clear)

29 , 1.6 DT 50 , 23.5 DT
74 , 38.0 DT 103 , 46.4 DT
118 , 48.0 DT

Regression Coefficient A = −35.59856934 — SHIFT S-VAR ▶ ▶ 1 =

Regression Coefficient B = 1.495939413 — SHIFT S-VAR ▶ ▶ 2 =

Regression Coefficient C = −6.71629667 × 10⁻³ — SHIFT S-VAR ▶ ▶ 3 =

$\hat{y}$ when x_i is 16 = −13.38291067 — 16 SHIFT S-VAR ▶ ▶ ▶ 3 =

$\hat{x}_1$ when y_i is 20 = 47.14556728 — 20 SHIFT S-VAR ▶ ▶ ▶ 1 =

$\hat{x}_2$ when y_i is 20 = 175.5872105 — 20 SHIFT S-VAR ▶ ▶ ▶ 2 =